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Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

(*First Revision*)

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NEW DELHI 110002

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Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

(First Revision)

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Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Parts I to VI) (First Revision) was adopted by the Indian Standards Institution on 12 May 1978, after the draft finalized by the Physical Methods of Test Sectional Committee had been approved by the Textile Division Council.

0.2 This standard was first published in 1954 which covered methods for determination of various length parameters of cotton fibres using Balls (Sledge) Sorter Method, Ahmad-Nanjundayya Stapling Apparatus Method and Baer (Comb) Sorter Method. The standard has been revised to include two more methods, namely, Thickness Scanning Method (Uster Stapling Apparatus) and Optical Scanning Method (Digital Fibrograph). Also the existing methods have been updated on the basis of experience gained during their use and developments that have taken place after the publication of the standard.

0.3 The fibre length of cotton is directly related to its spinning performance; generally speaking, longer cottons can be spun to finer counts. The method of estimating fibre length or 'staple' of cotton used in the trade has long been accepted to be liable to considerable subjective and personal errors, and the need for accurate methods of determining the mean fibre length of cotton and the proportion by weight of fibres of different length grades in cotton has long been recognized.

0.4 The methods given in this standard are intended for the estimation of different length parameters like mean length, effective length, upper quartile length, half-fall length, span length, percent short fibres, coefficient of variation of length, and uniformity index of a sample of cotton fibres, raw as well as processed. Part I of this standard is a necessary adjunct to other parts of the standard.

0.5 The length parameters measured by different instruments differ from one another, and no inter-relationship can be given with sufficient accuracy. However, experimental data broadly show that a cotton of

32 mm effective length by the Comb Sorter may give 27 to 28 mm effective length by the Uster Staple Diagram Apparatus, 30 mm upper quartile length by the Sledge Sorter, and 27 mm 2·5 percent span length by the Digital Fibrograph. The mean fibre length may be about 25 mm by the Comb Sorter, Sledge Sorter and A. N. Stapling Apparatus, while the Uster instrument may give a value of 21 mm.

0.6 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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*Rules for rounding off numerical values (*revised*).

Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

PART I GENERAL

(First Revision)

1. SCOPE

1.1 This standard (Part I) gives general information, like terminology, sampling, precision of test results, etc, regarding the methods for determination of length parameters of cotton fibres.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Mean Length — The average length of all fibres in the sample, based on weight-length or relative number-length distribution.

2.2 Upper Quartile Length — The length which is exceeded by 25 percent of the fibres, by weight or number, in the sample.

2.3 Effective Length — The upper quartile length of the distribution excluding fibres below half the upper quartile, and is obtained by prescribed geometric constructions on a cumulative length frequency diagram based on number.

2.4 Span Length — The minimum length spanned by a specified percentage of the fibres in a randomly aligned representative tuft. Thus, 2·5 percent span length is the length exceeded by only 2·5 percent of the total number of fibres in the tuft; similarly, 50 percent span length is the length exceeded by only 50 percent of the fibres.

2.5 Half-Fall — The fibre length, higher than the modal length, having half the modal frequency (by weight).

2.6 Percent Short Fibre — The percentage of fibres less than half the effective length (or less than any specified length).

2.7 Uniformity Index — The ratio between two span lengths expressed as a percentage of the longer length.

2.8 Coefficient of Variation of Length — The standard deviation of the weight — length or relative number — length frequencies expressed as a percentage of the mean length.

3. ATMOSPHERE FOR CONDITIONING AND TESTING

3.1 The atmospheric conditions are not critical for fibre length measurements; however, to reduce difficulties in fibre handling and to provide uniform ambient conditions for electronic instruments used for testing, standard atmosphere of relative humidity 65 ± 2 percent and temperature of 27 ± 2°C (IS : 196-1966*) is recommended.

4. SAMPLING

4.1 Laboratory Sample from Small Bulk (Up to 10 kg) — The loose raw cotton is spread out in an even layer, and about 200 tufts, each of about 0·5 g, are picked up at random to form the laboratory sample. For convenience, the bulk may be divided into a number of equal portions, and equal number of tufts drawn from each portion to comprise, in all, about 200 tufts.

4.1.1 *Representative Sliver from Laboratory Sample* — The laboratory sample is divided into 20 to 30 approximately equal parts, and a small tuft of fibres is extracted from each part at random to constitute a total mass of about 300 mg. These are cleaned, disentangled and somewhat parallelized by hand, and joined together to form a hand-made sliver, which is then passed about 10 times through a draw-box, having a draft of 4, to obtain a well-mixed sliver in which the fibres are reasonably parallel to one another. This shall constitute the test sample.

NOTE — The sliver forms the basis for testing by methods given in Parts II to V only.

5. PRECISION OF TEST RESULTS

5.0 In all the test methods the precision of the estimates depends upon a number of factors including the nature of the cotton, tuft to tuft variation, variation within tufts, and the operators' skill. The estimates of error given provide only broad guidelines.

5.1 Array Method — Effective length, mean length, and percent short fibre estimated from the average of two tests have precision of about ± 4 percent, ± 6 percent and ± 4 percent respectively.

5.2 Fractionation Method — Length values estimated from the average of two tests have precision of about ± 3 percent.

5.3 Cut and Weigh Method — The average of three tests for mean fibre length is precise to about ± 3 percent.

5.4 Thickness Scanning Method — The length parameters obtained on this apparatus have generally the same levels of precision as the comb sorter results (*see* **5.1**).

5.5 Optical Scanning Method — For the average of tests on two specimens, the 2·5 percent span length, 50 percent span length and the uniformity index have precision of about ± 3 percent, ± 4 percent and ±4 percent respectively.

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*Atmospheric conditions for testing (*revised*).

Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

PART II ESTIMATION OF LENGTH AND LENGTH DISTRIBUTION BY THE ARRAY METHOD

(First Revision)

1. SCOPE

1.1 This standard (Part II) prescribes a method for estimation of mean fibre length, effective length, percent short fibres and coefficient of variation of length by array method.

2. PRINCIPLE

2.1 A numerical sample of fibres is arranged in the form of an array in the descending order of length, and from a tracing of this array the effective length, mean length, percent short fibre and coefficient of variation of length are calculated.

3. APPARATUS

3.1 Two Comb Sorters — to prepare the fibre array, each comprising a bed of combs, an upper and a lower set — each spaced about 5 mm apart.

3.2 Accessories — as given below:

a) Fibre grip,
b) Teasing needle,
c) Rake to press in the fibres,
d) Velvet pad, and
e) Rectangular perspex scale (160 × 80 mm) marked in 5 mm squares.

4. PROCEDURE

4.1 Preparation of Aligned Tuft from the Test Sample (Using Two Comb Sorters)

4.1.1 Place one sorter in a suitable position such that the first of the bottom combs which can be dropped in succession faces the operator. Lift the upper combs, and lay the representative sliver (*see* **4.1.1** of Part I) towards the right and across the lower bed of combs; about 20 to 30 mm of the sliver should project beyond the nearest comb. Press the sliver into the combs with the rake. Remove the projecting fibres with the grip, and square the sliver to obtain alignment with the first comb.

4.1.2 Place the second sorter conveniently by the side of the first, but with the last of the bottom combs towards the operator. Lift the upper combs.

4.1.3 Drop the first bottom comb of the first sorter, so that about 5 mm of the squared end of the sliver projects out. Using the fibre grip, remove these fibres in short draws of full width, and place the tufts so drawn towards the left and across the bottom combs of the second sorter, such that the aligned ends of the tufts lie along the row of needles of the last bottom comb (nearest the operator). The fibres should be laid straight and at right angles to the comb rows. Press each tuft down into the combs with the rake. Drop the second bottom comb of the first sorter, and continue to transfer and pile up tufts on the second sorter until about 25 mg (or sufficient quantity) of fibres to prepare an array of about 100 to 150 mm length is built up.

4.1.4 Lower the upper combs.

4.2 Preparation of the Fibre Array

4.2.1 Turn the sorter round through 180 degrees.

4.2.2 Drop sufficient number of lower combs and raise upper combs, wherever necessary, until the longest fibres project about 5 mm.

4.2.3 Using the grip, pull out small tufts of successively shorter lengths. Comb and straighten fibres in each tuft, and lay them side by side on the velvet pad such that the free ends of the tufts lie along a straight base line. A continuous array of uniform density is produced by skillfully using the testing needle and a forefinger to arrange each tuft perpendicular to the base line and joining up with the previous one. Successive top and bottom combs are moved as shorter and shorter fibres are pulled out and joined into the pattern. The last few tufts should be very carefully arranged so that no short fibres are lost. It should also be ensured that the pattern is of uniform density throughout as the ultimate evaluation is based on this assumption.

4.2.4 Trace the outline of the fibre array prepared on a sheet of translucent paper (*see* Fig. 1).

5. CALCULATION AND EXPRESSION OF RESULTS

5.1 Calculate the following length parameters from the comb sorter diagram (*see* Fig. 1).

5.1.1 *Mean Length* — Determine the area of the comb sorter diagram using either the special transparent scale or a planimeter; divide the area expressed in square millimetres by the length of the base (mm) to obtain mean fibre length (mm).

5.1.2 *Maximum Length* — Determine the maximum length OA from the tracing.

5.1.3 *Effective Length* — Make geometric constructions as shown in Fig. 1 as follows:

a) Halve the maximum length OA at Q and draw a line parallel to the base through Q to cut the curve at P'; drop a perpendicular from P′ to meet the base line at P.

b) Mark off $OK = OP/4$ and erect a perpendicular KK' to cut the curve at K'.

c) Halve KK' at S and draw a parallel line to the base through S to cut the curve at R'; drop a perpendicular from R' to meet the base line at R.

d) Mark off $OL = OR/4$ and erect a perpendicular LL' cutting the curve at L'. Effective length is the length represented by LL'.

5.1.4 *Upper Quartile Length* — Mark off $OU = OB/4$ and erect a perpendicular UU' to cut the curve at U'. UU' is equal to the upper quartile length.

5.1.5 *Percent Short Fibres* — Percent short fibre equals $\frac{RB}{OB} \times 100$ where OB is the total length of the diagram.

5.1.6 *Fibre Length Distribution* — Divide the comb sorter diagram into length groups of 4 mm interval (*see* Fig. 2). An improvised scale as shown in Fig. 3 can facilitate the marking of group limits; place the comb sorter tracing over the scale with the base line coinciding with the zero line, and mark off the points where the curve intersects the parallel lines. Drop perpendiculars to the base line from the marked points (*see* Fig. 2) and record the distances along the base in a tabular form as given in Table 1. Calculate the mean length and coefficient of variation of length as given in Table 1.

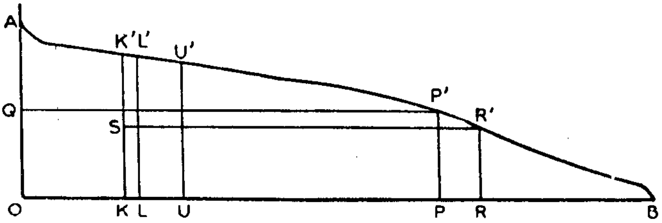

FIG. 1 COMB SORTER DIAGRAM

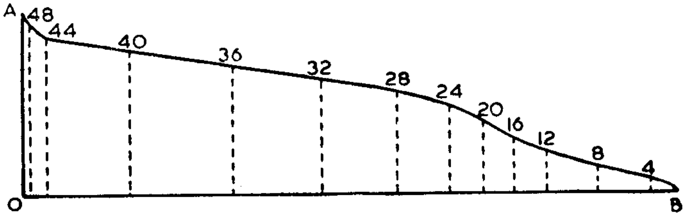

FIG. 2 COMB SORTER DIAGRAM

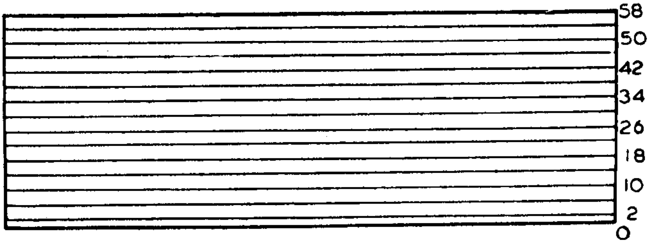

FIG. 3 SCALE

TABLE 1 LENGTH FREQUENCY DATA FROM COMB SORTER DIAGRAM

(*Clause* 5.1.6)

LOWER GROUP LIMIT (1)	GROUP LENGTH, l_i (2)	DISTANCE ALONG BASE (3)	RELATIVE GROUP FREQUENCY, f_i^1 (4)	PERCENTAGE GROUP FREQUENCY, f_i (5)	$f_i l_i$ (6)	$f_i l_i^2$ (7)
mm	mm	mm				
48	50	1	1	0·6	30·0	1 500·0
44	46	6	5	2·8	128·8	5 924·8
40	42	29	23	12·8	537·6	22 579·2
36	38	58	29	16·2	615·6	23 392·8
32	34	82	24	13·4	455·6	15 490·4
28	30	103	21	11·7	351·0	10 530·0
24	26	118	15	8·4	218·4	5 678·4
20	22	127	9	5·0	110·0	2 420·0
16	18	135	8	4·5	81·0	1 458·0
12	14	144	9	5·0	70·0	980·0
8	10	158	14	7·8	78·0	780·0
4	6	171	13	7·3	43·8	262·8
0	2	179	8	4·5	9·0	18·0
			179 Σf_i^1	100·0 Σf_i	2 728·8 $\Sigma f_i l_i$	91 014·4 $\Sigma f_i l_i^2$

$$\text{Mean length} = \frac{\Sigma f_i l_i}{\Sigma f_i} = \frac{2\,728 \cdot 8}{100} = 27 \cdot 3 \text{ mm}$$

$$\text{Variance} = \frac{\Sigma f_i l_i^2 - \dfrac{(\Sigma f_i l_i)^2}{\Sigma f_i}}{\Sigma f_i} = \frac{91\,014 \cdot 4 - 74\,463 \cdot 5}{100} = 165 \cdot 5$$

$$\text{Standard deviation } (\sigma) = \sqrt{\text{variance}} = \sqrt{165 \cdot 5} = 12 \cdot 9$$

$$\text{Coefficient of variation } (CV) = \frac{\sigma}{\text{Mean length}} \times 100 = \frac{12 \cdot 9}{27 \cdot 3} \times 100 = 47 \cdot 2 \text{ percent}$$

6. REPORT

6.1 The report shall include the following information:

a) Mean length in mm (rounded off to one decimal place),

b) Effective length in mm (rounded off to one decimal place),

c) Upper quartile length,

d) Percent short fibres (rounded off to two significant figures), and

e) Coefficient of variation of length (rounded off to two significant figures).

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Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

PART III ESTIMATION OF LENGTH AND LENGTH DISTRIBUTION BY THE FRACTIONATION METHOD

(First Revision)

1. SCOPE

1.1 This standard (Part III) prescribes method for estimation of mean fibre length, upper quartile length, half-fall length and coefficient of variation of length by fractionation method.

2. PRINCIPLE

2.1 Fibres drawn from a representative sliver are sorted out into groups according to their length, and the mass of each group determined to obtain a length-mass distribution of the fibres in the sample. The length parameters which can be derived from the data are mean length, upper quartile length, half-fall length and coefficient of variation of length.

3. APPARATUS

3.1 Sledge Sorter — for fractionation of fibres according to their length. The instrument sorts fibres from a sliver fed into it and deposits them on a long one-way plush, in the ascending order of length. It consists of a sledge comprising the sliver feeding machanism and the delivery rollers.

3.2 Accessories — as given below:

a) Black one-way plush (2 000 × 200 mm);
b) Calibrated tape; and
c) Torsion balance, 25 mg capacity, 0·1 mg accuracy.

4. PROCEDURE

4.1 Preparation for Sorting

4.1.1 Check the sorter according to instructions in the operator's manual.

4.1.2 Feed the representative sliver (*see* **4.1.1** of Part I) into the feed box and position it in the sledge.

4.1.3 Operate the trigger on the feed box and advance the sliver in steps so that its end is caught between the delivery rollers when the wheels of the sledge are rotated anticlockwise until the system gets locked.

4.1.4 Hold the apparatus in the left hand. Tilt the feed box backward, and rotate the sledge wheels till the system is locked once again. Remove the fibres passing out of the delivery rollers.

4.1.5 Operate the trigger to advance the sliver and repeat step (**4.1.4**) until a uniform straight edge of the sliver is obtained. It is desirable to square off about 20 mm of sliver in the process.

4.2 Sorting the Fibres

4.2.1 Place the sorter on the plush with the arrow mark coinciding with the start mark on the calibrated tape. By operating the trigger, tilt the feed box backward and advance the sliver by one step. Push the sorter forward and roll it at an even speed until it reaches the end of the plush and gets mechanically locked.

4.2.2 Repeat step (**4.2.1**) 15 to 20 times so that the fibres deposited over the length of plush weigh 25 to 30 mg.

4.3 Collection of Length-Groups

4.3.1 Collect the deposited fibres in length-groups of 2 mm interval. Place a smooth steel rule across the plush in alignment with the 4 mm mark; use a smooth edged glass slide and remove the fibres deposited in the lower length-groups. These fibres are to be rejected. Next, align the steel rule with the 6 mm mark and collect fibres in the 4-6 mm group. Continue the operation until the deposit becomes negligible (below 0·5 percent of the mass of fibres deposited).

4.3.2 Remove extraneous fibres, if any, and weigh the fibre groups in a torsion balance of 0·1 mg accuracy; tabulate the masses against the corresponding class length values.

5. CALCULATION AND EXPRESSION OF RESULTS

5.1 Calculate mean length, coefficient of variation of length, upper quartile length and half-fall length from the mass of different group lengths as shown in Table 1. The values are based on frequency by mass and not by number.

TABLE 1 LENGTH FREQUENCY DATA FROM SLEDGE SORTER TEST

(*Clause* 5.1)

GROUP LIMITS	GROUP LENGTH, li	GROUP MASS, fi^1	PERCENTAGE GROUP FREQUENCY, fi	$fi\ li$	$fi\ li^2$
(1)	(2)	(3)	(4)	(5)	(6)
mm	mm	mg			
4-6	5	—	—	—	—
6-8	7	0·3	0·9	6·3	44·1
8-10	9	0·4	1·1	9·9	89·1
10-12	11	0·5	1·4	15·4	169·4
12-14	13	0·7	2·0	26·0	338·0
14-16	15	1·1	3·1	46·5	697·5
16-18	17	2·0	5·7	96·9	1 647·3
18-20	19	4·3	12·1	229·9	4 368·1
20-22	21	7·2	20·3	426·3	8 952·3
22-24	23	7·0	19·8	455·4	10 474·2
24-26	25	4·7	13·3	332·5	8 312·5
26-28	27	2·8	7·9	213·3	5 759·1
28-30	29	1·6	4·5	130·5	3 784·5
30-32	31	1·2	3·4	105·4	3 267·4
32-34	33	0·9	2·5	82·5	2 722·5
34-36	35	0·5	1·4	49·0	1 715·0
36-38	37	0·2	0·6	22·2	821·4
		35·4	100·0	2 248·0	53 162·4
		Σfi^1	Σfi	$\Sigma fi\ li$	$\Sigma fi\ li^2$

$$\text{Mean length} = \frac{\Sigma fi\ li}{\Sigma fi} = \frac{2\,248}{100} = 22{\cdot}48 = 22{\cdot}5 \text{ mm}$$

$$\text{Variance} = \frac{\Sigma fi\ li^2 - \dfrac{(\Sigma fi\ li)^2}{\Sigma fi}}{\Sigma fi} = \frac{53\,162{\cdot}4 - 50\,535{\cdot}0}{100} = 26{\cdot}27$$

$$\text{Standard deviation } (\sigma) = \sqrt{\text{Variance}} = \sqrt{26{\cdot}27} = 5{\cdot}12$$

$$\text{Coefficient of variation } (CV) = \frac{\sigma}{\text{Mean length}} \times 100 = \frac{5{\cdot}12}{22{\cdot}5} \times 100 = 22{\cdot}8 = 23\%$$

Upper Quartile Length

a) Cumulative sum of longest group equal to or greater than quartile = 33·6
b) Quartile = $fi/4$ = 25·0

(*Continued*)

TABLE 1 LENGTH FREQUENCY DATA FROM SLEDGE SORTER TEST — *Contd*

c) Difference [(a) — (b)] = 8·6

$$\text{Correction} = \frac{\text{Difference} \times \text{class interval}}{fi \text{ of group containing quartile [\textit{see} (b)]}} = \frac{8{\cdot}6 \times 2}{13{\cdot}3} = 1{\cdot}3 \text{ mm}$$

e) Lower limit of group containing quartile = 24·0 mm

f) Upper quartile length — (d) + (e) = 25·3 mm

Half-Fall Length

a) From the length frequency mass data draw a length frequency curve as shown in Fig. 1.

b) Draw a perpendicular from the sorter peak *P* to cut the length axis at *Q*. Mark off *R*, the mid-point of *PQ*, and draw a horizontal line through *R* to intersect the curve at *S*.

c) Draw a perpendicular from *S* to *T* on the length axis. The length *OT* is the half-fall.

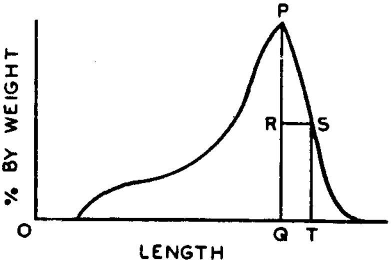

FIG. 1 GEOMETRICAL CONSTRUCTION TO ESTIMATE ' HALF-FALL '

6. REPORT

6.1 The report shall include the following information:

a) Mean length in mm (rounded off to one decimal place),

b) Upper quartile length in mm (rounded off to one decimal place),

c) Half-fall length, and

d) Coefficient of variation of length (rounded off to two significant figures).

Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

PART IV ESTIMATION OF MEAN FIBRE LENGTH BY CUT AND WEIGH METHOD

(First Revision)

1. SCOPE

1.1 This standard (Part IV) prescribes a method for estimation of mean fibre length by the cut and weigh method.

2. PRINCIPLE

2.1 A tuft of fibres, aligned at one end, is cut into three sections as shown in Fig. 1; each section is weighed. The first two sections are of predetermined length; assuming that all the fibres in the tuft are at least as long as the combined length of the first two sections and that the linear density of the fibre segments in the first and the last sections is the same, the average length of the last section is calculated from its mass and the length-mass ratio of the first section.

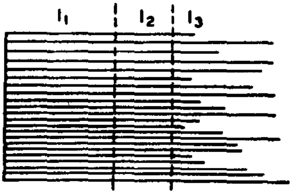

FIG. 1 ALIGNMENT AND SECTIONING OF FIBRE TUFT

3. APPARATUS

3.1 The Ahmad-Nanjundayya Stapling Apparatus* — for obtaining the mean fibre length by the cut and weigh method. The apparatus essentially consists of:

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*Mention of the name of specific (or proprietary) instruments is not intended to promote or give preference to the use of these instruments or exclude the use of other suitable instruments.

a) two sliding fibre grips,
b) two-bladed guillotine, and
c) a calibrated reference scale.

3.2 Torsion Balance — 5 mg capacity, 0·01 mg accuracy.

4. PROCEDURE

4.1 Check and calibrate the instrument according to the manufacturer's instructions.

4.2 Place the test sample (*see* **4.1.1** of Part **I**) across the bed of combs on the left side, so that the free end of the sliver projects about 20 mm to the right. Press the sliver into the combs with a rake.

4.3 Use an auxiliary pair of tweezers, and square the projecting end of the sliver to obtain an even edge about 5 mm beyond the nearest comb.

4.4 Bring the left pair of tweezers of the apparatus to the squared sliver end and withdraw a small tuft aligned at the nip of the tweezers. Remove loose fibres dragged along with the tuft by a small comb.

4.5 Turn the pair of tweezers round through 180°, slide it towards the right, and fix its position on the graduated scale. With a bent needle, guide the free length of tuft over the cutting platform and into the nip of the second pair of tweezers on the right.

4.6 With the two ends of the tuft firmly gripped, straighten the fibres by slightly moving the second pair of tweezers to the right.

4.7 Swing down the two-bladed knife and cut the tuft into three segments.

4.8 Collect the first and the third segments and weigh on a torsion balance of 0·01 mg accuracy (*see* Note).

NOTE — It is desirable that the first and third segments have nearly equal mass; this can be achieved by suitably adjusting the distance between the first pair of tweezers and the knife.

5. CALCULATION AND EXPRESSION OF RESULTS

5.1 Calculate the mean fibre length from the test data (*see* Fig. 1) as shown below in the following example:

Known length of the first section (l_1) = 12·4 mm
Known length of the second section (l_2) = 3·6 mm
Mass of the first section (W_1) = 1·28 mg
Mass of the third section (W_3) = 1·18 mg

$$\text{Average length of the third section } (l_3) = \frac{W_3 l_1}{W_1}$$

$$= \frac{1{\cdot}18 \times 12{\cdot}4}{1{\cdot}28} = 11{\cdot}4 \text{ mm}$$

$$\text{Mean fibre length } (lm) = l_1 + l_2 + l_3 = 12{\cdot}4 + 3{\cdot}6 + 11{\cdot}4 = 27{\cdot}4 \text{ mm}$$

6. REPORT

6.1 The report shall include mean fibre length in mm (rounded off to one decimal place).

Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

PART V ESTIMATION OF LENGTH AND LENGTH DISTRIBUTION BY THE THICKNESS SCANNING METHOD

(First Revision)

1. SCOPE

1.1 This standard (Part V) prescribes a method for estimation of mean fibre length, effective length, percent short fibres and coefficient of variation of length by the thickness scanning method.

2. PRINCIPLE

2.1 The thickness of an aligned tuft of fibres is measured at predetermined distances from the aligned end. It is assumed that the mean cross-sectional area of the fibres is the same at all points along the tuft and that the thickness readings are proportional to the number of fibres. A cumulative length frequency diagram is obtained from the measurements.

3. APPARATUS

3.1 Uster Staple Diagram Apparatus* — It essentially consists of:

a) a mechanical comb sorter and tuft holder,
b) a tuft forming unit, and
c) a thickness measuring device.

4. PROCEDURE

4.1 Calibrate and check the apparatus according to manufacturer's instructions.

4.2 Swivel back the upper comb bank and place the representative sliver (*see* **4.1.1** of Part I) across the lower bed of combs, so that about 30 mm length projects beyond the nearest comb. Press the sliver into the combs with a rake. Lower the upper combs.

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*Mention of the name of specific (or proprietary) instruments is not intended to promote or give preference to the use of these instruments or exclude the use of other suitable instruments.

4.3 Use the sliding fibre grip to square the sliver and bring its end in alignment with the first comb.

4.4 Drop the first lower comb; slide the fibre grip towards the aligned end of the sliver, seize the projecting fibres, move the grip back to the mid-stop, and transfer the fibres on to the transport comb by operating the crank on the right side. Repeat the operation until all the protruding fibres are transferred. Thereafter, raise the foremost upper comb and continue the transfer of fibres in the same manner. Build up a sufficiently thick (1 mm) aligned fringe of fibres, dropping or raising the foremost combs one by one, and transferring more fibres on to the transport comb.

4.5 Detach the transport comb along with the aligned fringe of fibres, and place it on the tuft forming device. Insert the aligned end of the fringe of fibres into the slot in the clamping block, and clamp the fibre ends tight by means of the plunger.

4.6 Remove the clamping block and mount it in the thickness measuring device. Guide the tuft through the narrow gauging slot and place a plush cover over the protruding length. Slowly lower the dial gauge feeler into the slot by operating the knob on the left; a vibrator automatically starts working and keeps the feeler in vibration for 30 seconds, after which it stops. Take the reading on the dial gauge after the vibrator stops working. The first reading is at 4 mm from the aligned end of the tuft. Raise the dial gauge. Move the tuft 2 mm towards the left by turning the crank on the right, and take the next thickness reading. Continue to take thickness readings at 2 mm intervals until the slot is empty.

4.7 The first thickness reading at 4 mm is generally the highest and is assumed to represent 100 percent of the fibres and all subsequent readings are expressed as percentage of this maximum thickness. However, in some cases, the maximum thickness may occur at a higher distance and this maximum value should be taken as the base for calculations. Enter the percent thickness values against distances from the aligned end.

5. CALCULATION AND EXPRESSION OF RESULTS

5.1 Construct the staple diagram (based on frequency by number) from the dial readings at successive intervals from the aligned end (*see* Table 1).

5.2 Make geometric constructions as given in Fig. 1 and 2 of Part II and obtain effective length and percent short fibre as shown in **5.1.3** and **5.1.5** of Part II.

5.3 Work out fibre length distribution, mean length and coefficient of variation of fibre length from the data as shown in Table 1, or from the staple diagram as detailed in **5.1.6** of Part II.

TABLE 1 LENGTH FREQUENCY DATA FROM TESTS WITH USTER STAPLE DIAGRAM APPARATUS

(*Clauses* 5.1 *and* 5.3)

GROUP LENGTH (DISTANCE FROM ALIGNED END), *li*	DIAL READING	CUMULATIVE FREQUENCY, PERCENT	PERCENT GROUP FREQUENCY, *fi*	*fi li*	*fi li*²
(1)	(2)	(3)	(4)	(5)	(6)
mm					
40	0	0	0	0	0
38	4	0·3	0·3	11·4	433·2
36	10	0·8	0·5	18·0	648·0
34	32	2·5	1·7	57·8	1 965·2
32	82	6·4	3·9	124·8	3 993·6
30	116	12·9	6·5	195·0	5 850·0
28	286	22·2	9·3	260·4	7 291·2
26	410	31·8	9·6	249·6	6 489·6
24	542	42·1	10·3	247·2	5 932·8
22	668	51·8	9·7	213·4	4 694·8
20	788	61·1	9·3	186·0	3 720·0
18	890	69·0	7·9	142·2	2 559·6
16	980	76·0	7·0	112·0	1 792·0
14	1 050	81·4	5·4	75·6	1 058·4
12	1 102	85·5	4·1	49·2	590·4
10	1 150	89·0	3·5	35·0	350·0
8	1 204	93·3	3·3	26·4	211·2
6	1 234	95·6	2·3	13·8	82·8
4	1 290	100·6	4·4	17·6	70·4
			100·0 Σfi	2 035·4 $\Sigma fi\, li$	47 733·2 $\Sigma fi\, li^2$

$$\text{Mean length } (lm) = \frac{\Sigma fi\, li}{\Sigma fi} = \frac{2\,035{\cdot}4}{100} = 20{\cdot}4 \text{ mm}$$

$$\text{Variance} = \frac{\Sigma fi\, li^2 - \dfrac{(\Sigma fi\, li)^2}{\Sigma fi}}{\Sigma fi} = \frac{47\,733{\cdot}2 - 41\,428{\cdot}5}{100} = 63{\cdot}047$$

$$\text{Standard deviation } (\sigma) = \sqrt{\text{Variance}} = \sqrt{63{\cdot}047} = 7{\cdot}94$$

$$\text{Coefficient of variation } (CV) = \frac{\sigma}{lm} \times 100 = \frac{7{\cdot}94}{20{\cdot}35} \times 100 = 39 \text{ percent}$$

6. REPORT

6.1 Report shall include the following information:

a) Mean fibre length in mm (rounded off to one decimal place),

b) Effective length in mm (rounded off to one decimal place),

c) Percent short fibres (rounded off to two significant figures), and

d) Coefficient of variation of length (rounded off to two significant figures).

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Indian Standard

METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

PART VI ESTIMATION OF LENGTH AND LENGTH UNIFORMITY BY THE OPTICAL SCANNING METHOD

(First Revision)

1. SCOPE

1.1 This standard (Part VI) prescribes a method for estimation of 2·5 percent span length, 50 percent span length and uniformity index of cotton fibres by optical scanning method.

2. PRINCIPLE

2.1 A randomly aligned tuft of cotton fibres is scanned by an optical device and the minimum length spanned by certain specified percentages of the fibres is determined. The ratio of lengths spanned at two percentages is considered as a measure of fibre length uniformity.

3. APPARATUS

3.1 Digital Fibrograph* — It is an optical instrument which scans a randomly aligned tuft of fibres to estimate the length of specific portions of the length frequency distribution, like 2·5 percent span length, 50 percent span length.

3.2 A Set of Hand Combs or a Fibro-Sampler — for preparation of tufts.

4. PROCEDURE

4.1 Preparation of Test Specimen — Prepare the test specimens from the laboratory sample (*see* **4.1** of Part I) by one of the following methods given in **4.1.1** or **4.1.2**.

4.1.1 *Hand Combing Method* — Pick up a handful of cotton from the laboratory sample and separate it into two parts by pulling so as to expose a fresh surface of projecting fibres. Holding one of the hand combs in one hand and the opened lump of cotton in the other, transfer some of the projecting fibres on to the comb. Pick fresh lumps of cotton, and proceed in the same manner so that a pair of combs is filled with sufficient quantity of fibres drawn from 8 to 10 randomly picked lumps. Hold one comb in each hand, and untangle and parallelize the projecting fibres by mutual combing. The pair of combed beards constitutes the test specimen.

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*Mention of the name of specific (or proprietary) instruments is not intended to promote or give preference to the use of these instruments or exclude the use of other suitable instruments.

4.1.2 *Fibro-Sampler Method* — Mount one of the fibro-sample combs in the comb holder of the fibro-sampler, with the teeth upper most. Place the laboratory sample in the cage and press it against the perforated surface. Maintain the pressure and rotate the sample holder round the drum counter-clockwise through 360°. Remove the loaded comb from the holder. Turn the sample in the cage to expose a fresh surface, and mount fibres in one more comb. Either one or a pair of combed beards constitute the test specimen depending upon the model of the instrument being used.

4.2 Optical Scanning of Test Specimens

4.2.1 Assure that the fibrograph is in proper operating condition; check calibration according to instruction manual.

4.2.2 Insert the loaded pair of combs into the comb holder, and brush the fibres downward carefully to remove loose fibres and straighten the rest.

NOTE — In some fibrograph models a single comb constitutes the test specimen.

4.2.3 Lower the light house; wait for the signal to indicate 'balance'. See that the amount counter reading is within specified limits. If the quantity of fibres is too much or too less, reject the test specimens and prepare fresh ones.

4.2.4 Follow the procedure laid down for respective models and record the 20 percent and 2·5 percent span length values.

5. CALCULATION AND EXPRESSION OF RESULTS

5.1 Express 2·5 percent span length and 50 percent span length correct to 0·1 mm. Calculate the uniformity index as follows:

$$\text{Uniformity index} = \frac{\text{50 percent span length}}{\text{2·5 percent span length}} \times 100$$

6. REPORT

6.1 The report shall include the following information:

a) 50 percent span length,
b) 2·5 percent span length, and
c) Uniformity index (rounded off to two significant figures).

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AMENDMENT NO. 2 JULY 1989
TO
IS : 233 (Parts 1 to 6) - 1978 METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

(*First Revision*)

(*Cover page, pages* 1, 2, 3 *and* 4, *IS Number*) — Substitute 'IS : 233 (Parts 1 to 4)-1978' *for* 'IS : 233 (Parts 1 to 6)-1978'.

(*Clause* **0.1**, *line* 1) — Substitute '(Parts 1 to 4)' *for* '(Parts 1 to 6)'.

(*Clause* **0.2**, *line* 7) — Insert the following after the word '(Fibrograph)':

'The Balls (Sledge Sorter) Method and Ahmad-Nanjundayya Stapling Apparatus Method have been deleted because these methods are not used commercially.'

(*Clause* **0.5**, *lines* 5 *and* 6) — Delete the words '30 mm upper quartile length by the Sledge Sorter,'.

(*Clause* **0.5**, *line* 8) — Delete the words 'Sledge Sorter and A. N. Stapling Apparatus'.

(*Clauses* **5.2** *and* **5.3**) — Delete.

(*Pages* 13 *to* 18, *Parts* 3 *and* 4) — Delete.

(*Pages* 19 *to* 21, *IS Number*) — Substitute 'IS : 233 (Part 3)-1978' *for* 'IS : 233 (Part 5)-1978'.

(*Page* 19, *Title and clause* **1.1**, *line* 1) — Substitute 'Part 3' *for* 'Part 5'.

(*Pages* 23 *and* 24, *IS Number*) — Substitute 'IS : 233 (Part 4)-1978' *for* 'IS : 233 (Part 6)-1978'.

(*Page* 23, *Title and clause* **1.1**, *line* 1) — Substitute 'Part 4' *for* 'Part 6'.

(TDC 1)

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AMENDMENT NO. 1 MARCH 1980

TO

IS:233(Parts I to VI)-1978 METHODS FOR DETERMINATION OF LENGTH PARAMETERS OF COTTON FIBRES

(First Revision)

Corrigenda

[*Page 15, Table 1, under 'Upper Quartile Length', Sl No.*(b)] - Substitute the following for the existing matter:

'b) Quartile $= \frac{\Sigma fi}{4} = 25.0$'

(*Page 24, clause 4.2.4, line 2*) - Substitute '50 percent' *for* '20 percent'.

((TDC 1)

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